City of Bremerton

Sediment Sampling and Analysis Plan Addendum: Round II

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October 2016

CERTIFICATE OF ENGINEER

The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seal as a professional engineer licensed to practice as such, is affixed below.

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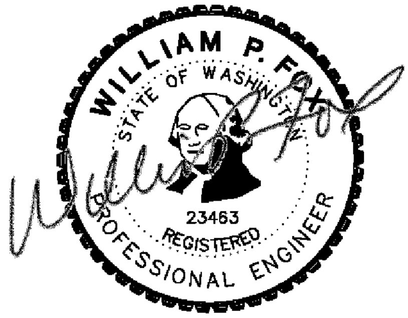

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Appendix A: 2015 Sediment Sampling Laboratory Results

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LIST OF ACRONYMS

CSO	Combined Sewer Outfall
DGPS	Differential Global Positioning System
EIM	Environmental Information Management
MDL	Method Detection Limit
NPDES	National Pollutant Discharge Elimination System
PQL	Practical Quantitation Limit
PSEP	Puget Sound Estuary Program
RI/FS	Remedial Investigation/Feasibility Study
SCUM II	Sediment Cleanup Users Manual II
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SSAP	Sediment Sampling and Analysis Plan
TOC	Total Organic Carbon
WAC	Washington Administrative Code

SECTION 1: INTRODUCTION

1.1 DISCUSSION

Ecology issued NPDES Permit No. WA0029289 to the City of Bremerton on June 21, 2013. Condition S10 of the permit requires the City to conduct sediment monitoring at the treatment plants and selected Combined Sewer Outfall (CSO) outfall locations. This monitoring is required in order to determine compliance with the SMS for both untreated CSO and treated East and West Plant discharges. The report documenting this monitoring is due February 1, 2018.

1.1.1 2014 Sampling Plan

A Sediment Sampling and Analysis Plan (SSAP) was submitted in October 2014 and was approved in November 2014. The approved SSAP established sediment monitoring of the areas surrounding three CSO outfalls (OF-6, OF-7, and OF-13) and both treatment plant outfalls (West and East Plant). An addendum to the SSAP proposed additional sampling at a fourth CSO outfall discharge location (OF-12), which was incorporated into the sampling schedule in summer 2015. Three sampling stations were established at each of the CSO outfall sites, and five sampling stations were established at each of the treatment plant outfalls, for a total of 22 sample sites. The SSAP additionally recommended a tiered testing approach, wherein samples would be tested for sediment chemistry only. If any samples exceeded Sediment Quality Standards (SQS) criteria, a second round of sampling would be triggered for confirmatory chemistry and bioassay testing.

1.1.2 Sediment Sampling and Report

Sediment sample collection was performed as described in the SSAP in July and August 2015. Samples were collected over two two-day periods, at intertidal or shallow subtidal stations at low tide on July 29 and 30 and at high slack at deeper stations from a sampling vessel on August 17 and 18. The stations sampled during these two sampling efforts were selected according to their accessibility at either high or low tide. The intertidal or shallow subtidal stations sampled in July were: OF6-1–3, 12-1, 12-3, and 13-1–3. The deeper stations sampled in August were: WP-1–5, EP-1–5, OF7-1–3, and 12-2. The samples were analyzed for the 47 SQS chemicals, conventionals, and dioxins and furans. The full lab results packets are included in Appendix A. Total volatile solids, though included in the SSAP for stations WP-1–5 per Ecology comments, were inadvertently omitted from the sediment chemistry. This omission will be addressed in the second round of sampling to be conducted.

A draft *Sediment Monitoring Study Report* documenting the results of the sediment sampling was submitted to Ecology in January 2016. Data results were uploaded to Ecology's Environmental Information Management (EIM) Database under the study name BREMSED2015. The report was not approved by Ecology due to errors in the results tables and references to older versions of guidance documents. However, the bulk of the report's conclusions are unaffected by these errors and are summarized below. Corrected results tables are included in Appendix A.

1.1.3 Sampling Report Conclusions

The sediment sampling stations and chemistry results can be split up into three distinct categories, which are discussed below.

Table 1 Sample Results Exceeding SQS/LAET Criteria

Parameter	SQS	SIZMax	Sand Stations		
			13-1	13-2	6-2
NON-IONIZABLE ORGANIC COMPOUNDS (mg/kg, organic carbon)					
Dilution Factor			10	10	10
TOC			0.71	0.57	2.00
Chlorinated Benzenes					
1,2-Dichlorobenzene	2.3	2.3	3.4	4.2	
1,4-Dichlorobenzene	3.1	9	3.5	4.4	
1,2,4-Trichlorobenzene	0.81	1.8	3.7	4.6	1.3
Hexachlorobenzene	0.38	2.3	4.6	5.8	1.7
Phthalate Esters					
Butyl benzyl phthalate	4.9	64	5.2	6.5	
Bis[2-ethylhexyl]phthalate	47	78			150
Miscellaneous					
Hexachlorobutadiene	3.9	6.2	4.2	5.3	
IONIZABLE ORGANIC COMPOUNDS (µg/kg, dry weight)					
2,4-Dimethylphenol	29	29	63	63	63
Benzoic acid	650	650	960	960	960

Table 1 Sample Results Exceeding SQS/LAET Criteria

Parameter	SQS	SIZMax	Sand Stations				
			6-1	6-3	12-1	12-3	13-3
NON-IONIZABLE ORGANIC COMPOUNDS (mg/kg, organic carbon)							
Dilution Factor			5	5	10	10	5
TOC			0.24	0.23	0.33	0.41	0.22
Chlorinated Benzenes							
Hexachlorobenzene	22	70			33	33	
Miscellaneous							
Hexachlorobutadiene	11	120	15	15	30	30	15
N-nitrosodiphenylamine	28	40			32	32	
IONIZABLE ORGANIC COMPOUNDS (µg/kg, dry weight)							
2,4-Dimethylphenol	29	29	63	63	32	32	32
Benzoic acid	650	650	960	960			
Parameter	**SQS**	**SIZMax**	**Mud Stations**				
			WP-1	**WP-2**	**WP-3**	**WP-4**	**WP-5**
Dilution Factor			1	varies	varies	1	1
TOC			4.49	8.43	3.87	5.57	3.85
METALS (mg/kg, dry weight)							
Mercury	0.41	0.59	0.784	0.882	1.04	1.04	0.742
Phthalate Esters							
Butyl benzyl phthalate	63	900		4500(2)	140(1)		
Bis[2-ethylhexyl]phthalate	1300	1900		8500(3)	1800(2)		
Miscellaneous							
Total PCBs	130	1000		180(1)	310(1)		

(1) Dilution factor of 1
(2) Dilution factor of 5
(3) Dilution factor of 10

Gravel Stations

All of the East Plant sediment stations (EP-1, EP-2, EP-3, EP-4 and EP-5) and the offshore station at OF-12 (12-2) consisted of over 90 percent gravel content. A photo of the most successful grab sample at Station EP-3 is shown below in Figure 1.

Figure 1 Photo of Sediment Grab Sample at Station EP-3

The EP stations and the offshore 12-2 station are located in very swift tidal currents, with average daily maximum current speeds exceeding 1.1 meter/second (NOAA Tidal Current Predictions, Port Washington Narrows). As shown in the Hjulstrom Diagram in Figure 2 below, the maximum current speed and observed grain size (pebbles) are wholly consistent.

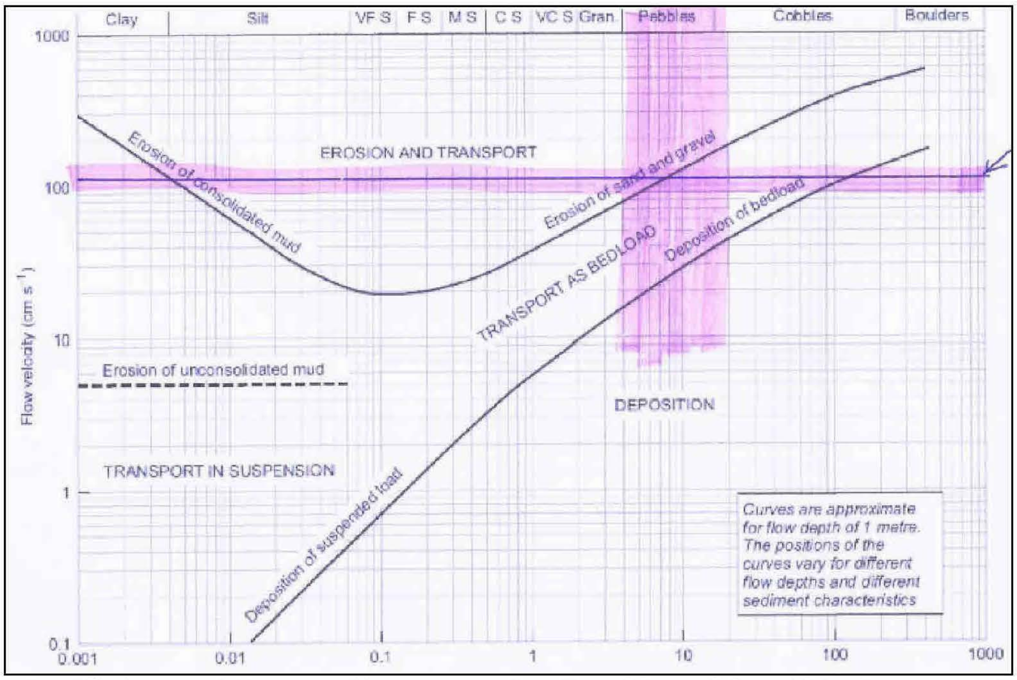

Figure 2 Hjulstrom Diagram Demonstrating Non-Depositional Environment in Port Washington Narrows Stations EP and 12-2 for Sand and Finer Grades

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It is not feasible to sample chemistry for the stations consisting predominantly of gravel. These sites are clearly not depositional environments, and therefore no further sediment sampling should be required at these locations.

Mud Stations

All of the West Plant sediment sampling stations consisted predominantly of fine-grained particles (though WP-3 alone had some fine sand), and would commonly be categorized as typical bay mud. Total organic carbon content of 4-8% and total sulfides exceeding 500 mg/kg are consistent with this characterization. A typical photo of a WP sediment sample is shown in Figure 3.

Per Table 1, the West Plant sediment samples met all SQS/LAET criteria with the exception of mercury and, in the case of WP-2 and 3, two phthalates and total PCBs.

Phthalates and PCBs are not typically associated with WWTP discharges. However, they are commonly associated with stormwater or CSO discharges, which have occurred in the vicinity of the West Plant Outfall. Additional investigation may be required to confirm the high phthalate and PCB concentrations at WP-2 and 3 and assess potential sources.

Figure 3 Photo of Sediment Grab Sample at Station WP-4

Figure 4 shows the range of mercury concentrations observed at the five West Plant Outfall stations with other sediment data in Sinclair Inlet provided in a 2009 USGS investigation of mercury concentrations in Sinclair Inlet. The observed mercury concentrations are in the middle of the range of other sediment stations in Sinclair Inlet. Remediation of the sediments in Sinclair Inlet, including those around the West Plant Outfall, will come from the remedial investigation/feasibility study (RI/FS) being conducted by USGS.

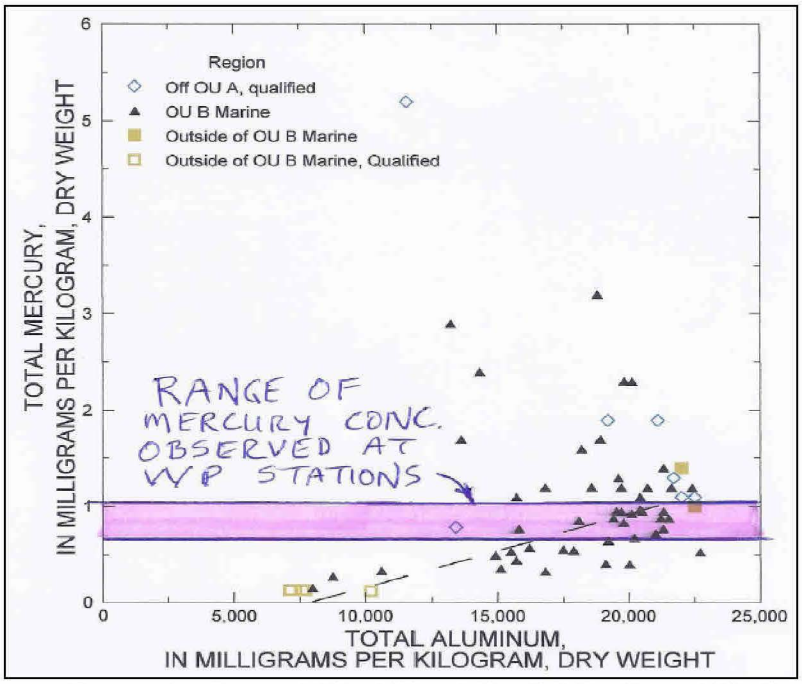

Figure 4 Mercury Concentrations at West Plant Outfall Sediment Stations Compared to USGS (2009) Sediment Mercury Data in Sinclair Inlet

Sand Stations

The remaining stations (OF-6, OF-7, OF-13, and OF-12) were all predominantly sand or sand and gravel. All of these stations had percent fines below 10 percent. Typical photos of sediment samples are shown in Figure 5.

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Station 6-1	Station 12-3

Figure 5 Photos of Sediment Grab Samples with High Sand Content

These stations all had very low concentrations of sulfides, ammonia and TOC compared to mud samples, and typically no odor. The TOC of all but three of these stations (OF13-1, 13-2, 6-2) fell below the 0.5 percent threshold for carbon normalization, and are thus compared to LAET dry weight criteria.

The only detected compound at any sand station that exceeded SQS or LAET criteria was bis[2-ethylhexyl]phthalate at Station 6-2. Station 6-2 is located straight offshore of the CSO Outfall OF-6 and a municipal storm drain. Station 6-2 also had the highest TOC of all sand stations at 2.0 percent, approximately three times higher than the next highest sand station, suggesting there is some organic input from the CSO and/or stormwater outfalls.

The only quality issue with the laboratory analysis was the aforementioned elevated reporting limits for the sand stations. As a result, there are a number of non-detected compounds at sand stations where the detection level exceeded SQS or LAET criteria, shown in blue type in Table 1. Although there is no reason to suspect that any of the sand stations would exceed criteria, Ecology may require resampling at all or some of these stations. Measures to reduce the detection levels by eliminating laboratory dilutions should be investigated and coordinated between the analytical laboratory and Ecology laboratory experts.

1.1.4 Ecology Review

A letter from Ecology dated March 29, 2016 regarding the sediment study report contains comments which fall broadly under a few categories:

- References to old or outdated guidance, analytical methods, and criteria. These references have been corrected in the updated results table and the following SSAP, and will be updated in the final data report due in 2018.

- Errors and inconsistencies in data result reporting, such as incorrect station coordinates, comparison to SQS instead of LAETs for stations with high concentrations of organic carbon, and differing units between some results and criteria. These errors have been corrected in the following SSAP, in the updated results tables in Appendix A, and in the final data report.

- Various formatting requirements for the results tables. These comments have also been addressed in the updated results tables in Appendix A.

- Omission of various components of the data report, including a reference to the EIM study ID, a comparison of study results with historical sediment conditions, further discussion of lab quality control, and various figures. These omissions will be addressed in the final data report due in 2018.

- Requirements for further chemical and bioassay analyses. The rest of this document will address these requirements.

1.2 PURPOSE

This Round II SSAP is intended to address the two bullet points at the top of page 5 of the March 29, 2016 Ecology letter (Figure 6). These comments pertain to the additional sampling that must be performed due to chemical exceedances at several sampling stations.

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City of Bremerton Sediment Monitoring
March 29, 2016
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- o Based on the chemicals results from the 2015 sampling event, confirmatory designation of sediments using bioassays was required per WAC 173-204-310(2)(a).
  - ▪ Please include a discussion in the data report outlining which stations should be included in bioassays.
- o Additionally, chemistry results presented in the data report are inconclusive due to detection limits above the SMS criteria provided in WAC 173-204-320.
  - ▪ The analytical results only show that the chemical is present and does not quantify at what concentration.
  - ▪ Therefore, samples will need to be recollected and analyzed for chemistry using better detection methods along with all conventionals.

Figure 6 Ecology Comments Regarding Additional Sediment Sampling

The rest of this document comprises an addendum to the 2014 SSAP for round two of sediment sampling. Its purpose is to:

- Establish additional sampling to be conducted for confirmatory chemical and bioassay testing, per Ecology comments
- Update the 2014 SSAP according to current guidance and sampling and analysis methods

1.3 REGULATORY GUIDANCE

Washington State has enacted sediment management standards (SMS) to "reduce and ultimately eliminate adverse effects in biological resources and significant health threats to humans from surface sediment contamination…" (WAC 173-204-320(2)). The SMS include chemical concentration and biological effects criteria, known as the sediment quality standards (SQS). These criteria are available in Tables 8-1 and 8-2 of the 2015 Department of Ecology (Ecology) document entitled *Sediment Cleanup Users Manual II*, or SCUM II. Copies of the SQS are included in Appendix B.

SECTION 2: SAMPLING DESIGN

2.1 PROJECT AND SAMPLING DESIGN

Chemical analytes for this sediment study will include the 47 SQS chemicals and conventional sediment variables listed in Appendix C. The previous SSAP recommended using a tiered testing approach wherein biological assay testing (also known as bioassay or toxicity testing) would only be conducted if a sample exceeds one of the chemical SQS. Sediments will be collected for biological analysis at select sampling sites which failed chemical tests, and will follow the procedures described herein.

2.2 SAMPLING SCHEDULE

Subject to DNR and Ecology approval of this SSAP Addendum, the sediment sampling described in herein will be conducted in Summer 2017. Prior to sampling, the sampling personnel will coordinate with the marine vessel contractor to check all provided sampling gear and confirm an appropriate sampling date. Laboratories will also be contacted to arrange delivery of the necessary sampling containers and schedule lab analyses of the samples.

2.3 PROPOSED SAMPLING LOCATIONS

The 2014 SSAP proposed sampling at four CSO outfall locations and both treatment plant outfall locations (Figure 7). Three stations were proposed at each CSO outfall location, and five at each treatment plant outfall location, for a total of 22 sample stations. 16 of these sites were sampled for sediment chemistry and conventional parameters during the 2015 sampling study.

2.3.1 Sand and Gravel Sites

Six of the sampling sites (EP-1–5, OF12-2) are in very high current speed locations and consist exclusively of coarse sand and gravel. These sites yielded very low amounts of sediment, and were analyzed for grain size only (with the exception of site EP-2, which was abandoned after eleven unsuccessful sampler casts). This SSAP Addendum proposes no further sampling at these sites, as they are clearly not depositional sites (see discussion in Section 1.1.3). This SSAP Addendum also proposes no additional sampling at OF7, as none of those samples exceeded chemical SQS and consisted largely of sand-sized particles.

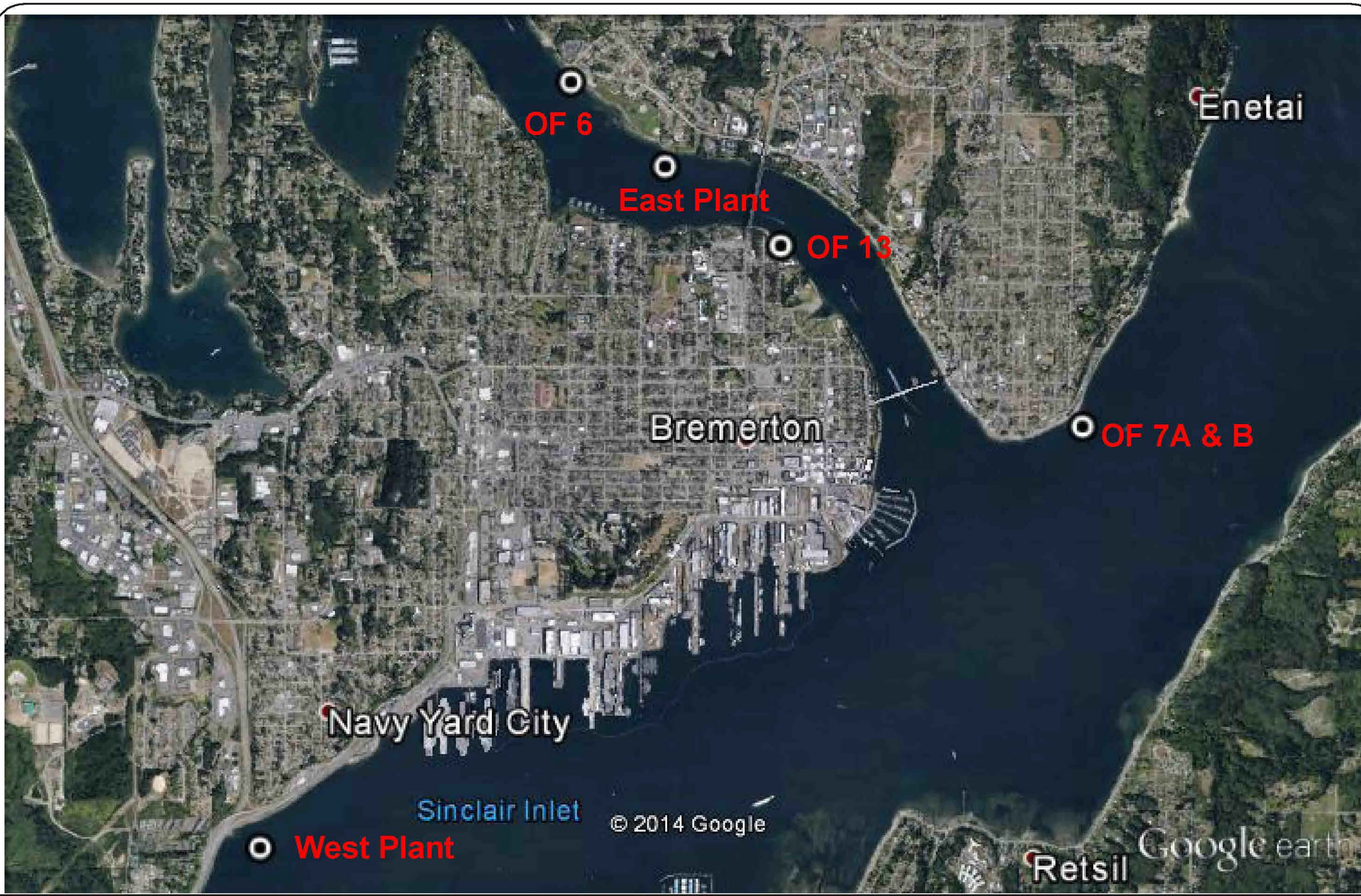

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Figure 7: 2015 Bremerton Sediment Sampling Outfall Locations

2.3.2 West Plant Outfall

All five of the West Plant outfall sediment stations exceeded SQS for mercury. Two of the West Plant stations also had exceedances of phthalate SQSs. Under the SMS, these stations should include biological testing. However, this SSAP does not include biological sampling at these stations for the following reasons:

- The West Plant outfall is located within Operable Unit B of the Puget Sound Naval Shipyard Superfund Site (see Figure 8). The Record of Decision (USEPA, 2000) has established remedial action for sediments that include the West Plant outfall site.

- Mercury found in the sediments near the West Plant outfall is attributed to historic naval shipyard activities, and is not associated with the West Plant discharge. As was shown in Figure 4, the mercury concentrations observed at Stations WP-1 through WP-5 are all within the range of mercury concentrations elsewhere in Operable Unit B of the Superfund site.

- Sediment investigations prior to and subsequent to the Record of Decision have already included biological sampling near the West Plant outfall. All remedial activities and decisions within the Superfund Site, including biological sampling, should be conducted under the CERCLA umbrella and the ENVVEST project.

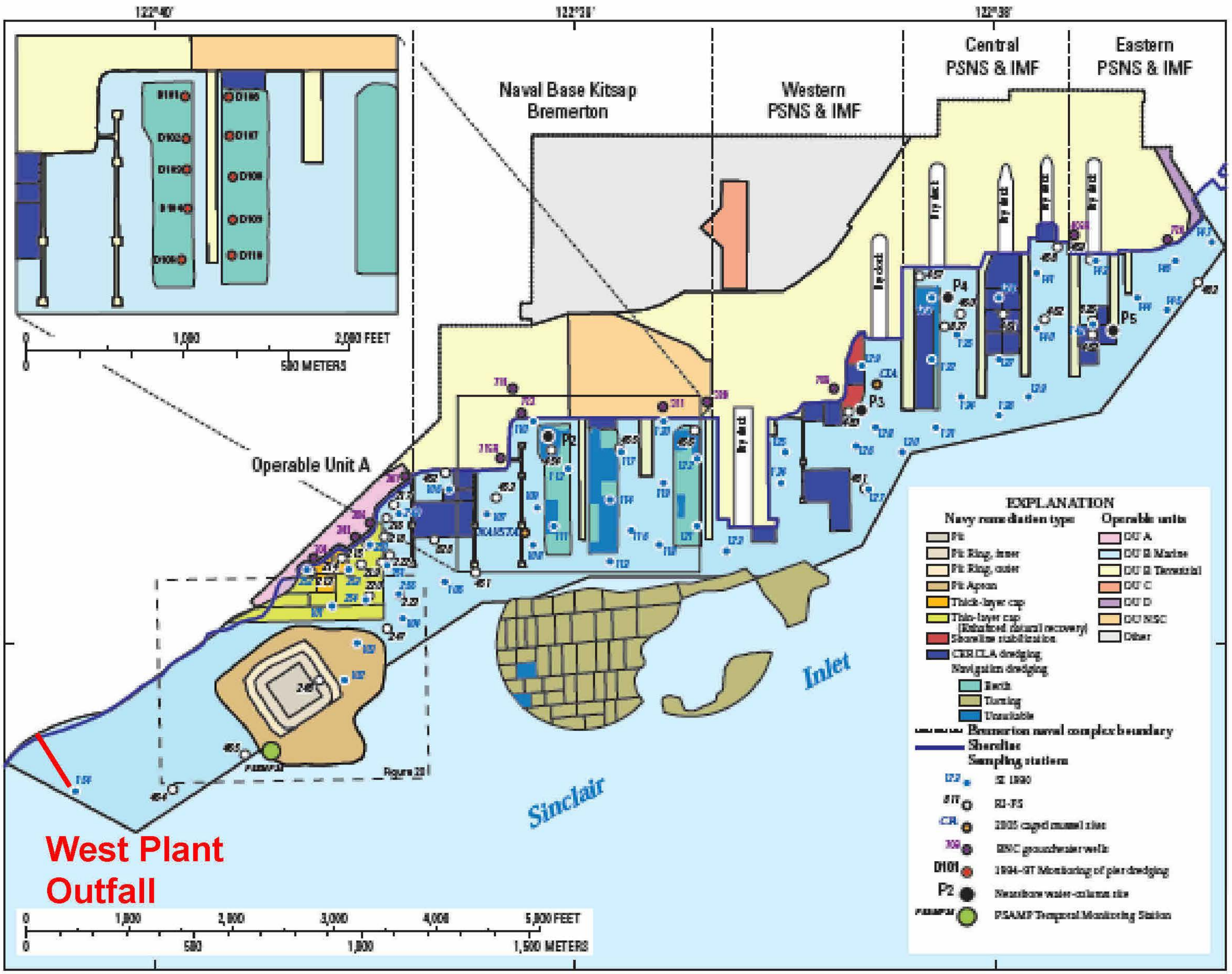


Figure 8: Location of PSNS Superfund Operable Units and Bremerton West Plant Outfall

Source: USGS, 2009

2.3.3 Supplementary Chemistry

Three stations are proposed for supplementary chemistry resampling, one at each CSO outfall site where detection levels exceeded SQS criteria. Parameters at these sites were all undetected, and exceedances were due to elevated MDLs resulting from sample dilutions. This SSAP proposes these sites only be retested for sediment chemistry and conventional parameters, with efforts made with the laboratory to ensure MDLs are below SMS criteria.

Sediment characteristics were sufficiently similar at the sample sites for each CSO outfall location, and chemistry results were comparable; therefore only one sample is proposed for each CSO outfall location instead of three. The sites proposed for resampling are OF6-1, 12-1, and 13-2 (Figures 9-11).

Table 2 Proposed Sampling Station Coordinates, Chemistry Only

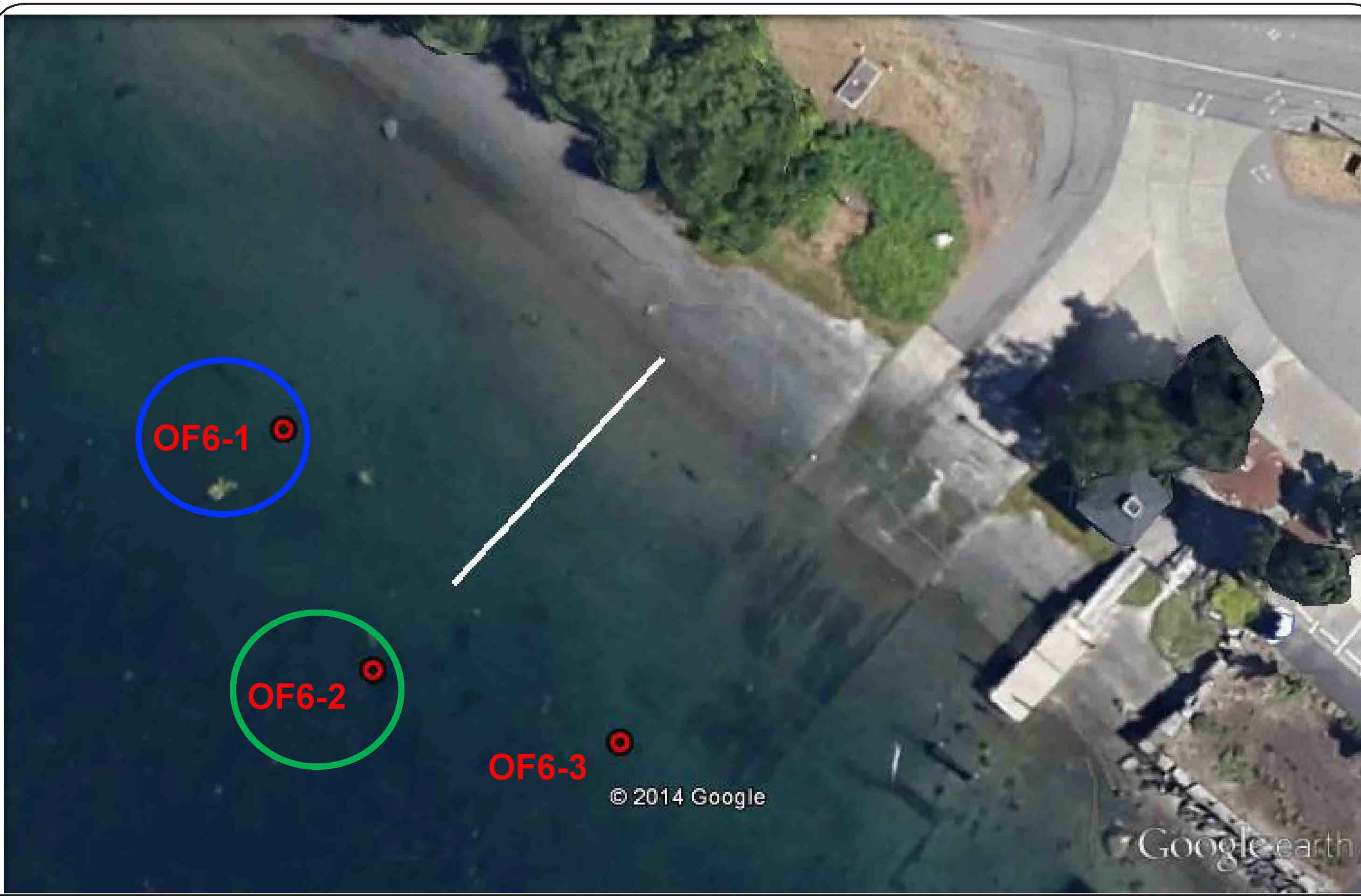
Station	N 47°	W 122°	Depth (ft)
OF6-1	35.15’	38.777’	1
OF12-1	34.703’	38.273’	2
OF13-2	34.644’	37.812’	0

2.3.4 Chemistry and Bioassay

Station OF6-2 had detected parameters at concentrations exceeding SMS criteria. Therefore, Station OF6-2 will be sampled for chemistry and bioassay testing (Figure 9). Reference sediments for this station must also be collected for the bioassay analysis. The reference site will be chosen based on sediment characteristics at OF6-2 and Ecology guidance.

Table 3 Proposed Sampling Station Coordinates, Chemistry and Bioassay

Station	N 47°	W 122°	Depth (ft)
OF6-2	35.14’	38.77’	3



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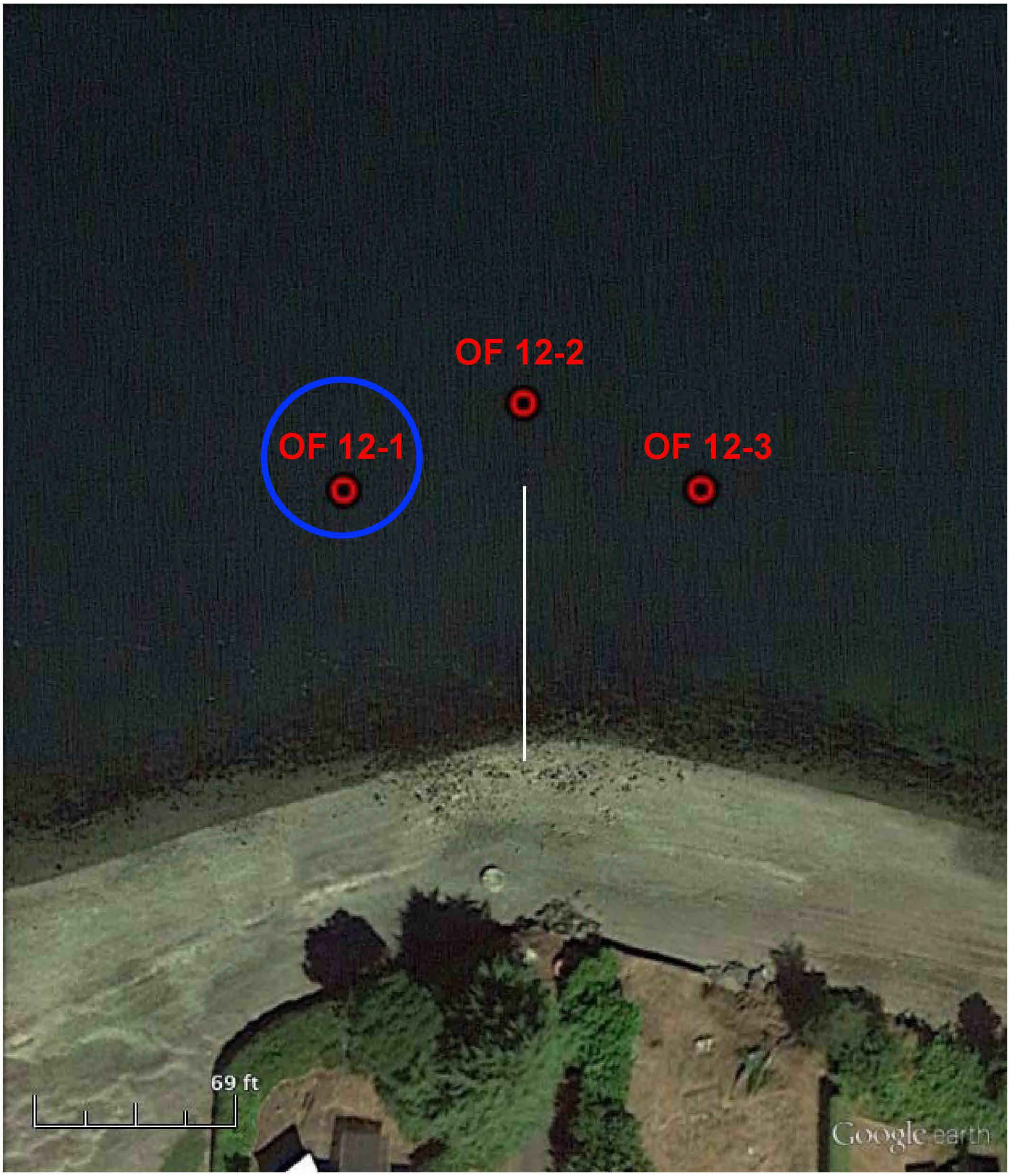
Chemistry Only

Chemistry and Bioassay

Figure 9: OF 6 Sampling Stations



Chemistry Only

Chemistry and Bioassay

Figure 10: OF 12 Sampling Locations

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Chemistry Only

Chemistry and Bioassay

Figure 11: OF 13 Sampling Stations

SECTION 3: FIELD SAMPLING METHODS

3.1 STATION POSITIONING

The stations for sediment sampling will be located in the field and documented using WAAS differential global positioning system (DGPS) technology. Station locations will be reported in latitude and longitude. Water depth will also be recorded at the time of sampling.

3.2 DECONTAMINATION PROCEDURES

The field sampling equipment, including the sampler and any stainless steel bowls and spoons used for compositing samples, will be decontaminated in the laboratory using the following procedure, per SCUM II recommendations:

- Scrub equipment with phosphate free detergent such as Alconox®
- Rinse with hot tap water or clean site water
- Air dry equipment
- Wrap equipment in plastic wrap

In the field the equipment will be cleaned of all adhering sediment with site water. In addition, sediment will be removed from the sampler by collecting the sample without contacting any surfaces of the sampling device to minimize the risk of contamination.

3.3 SAMPLE COLLECTION AND COMPOSITING

Sediment samples will be collected with a surface sediment sampler, either a van Veen or Ponar grab sampler, deployed from a research vessel with a power winch. Only the top 10 cm of any collected sample will be extracted from the sampler. Water will be carefully removed with a turkey baster to minimize loss of fines. Sediment samples will be inspected to meet acceptance criteria such as, the sampler is not overfilled, presence of overlying water, and depth of penetration into the sediment surface. Samples that do not satisfy the acceptance criteria will be rejected.

Based on prior sampling conducted in 2015, very low productivity in sampling is anticipated at some stations. Multiple casts are expected to be needed to obtain the required sample volume, and many casts will be discarded. Therefore, multiple casts will be made as close to the original cast as possible to collect the required volume of sediment for all the laboratory analyses. Sediment from multiple casts at a single station will be homogenized using a decontaminated stainless steel bowl and stainless steel spoon prior to placing the sample in the appropriate laboratory testing container. Minimum sediment sample sizes required for the analytical tests are listed in Table 4-6 (copy provided in Appendix D) of SCUM II.

If multiple casts are required, samples for the total sulfides and volatile organic compounds tests will be obtained directly from the sampler and placed in the appropriate laboratory container prior to homogenizing and sub-sampling sediment for the other analyses. These sample jars should have no headspace.

3.4 FIELD DOCUMENTATION

A field notebook will document all field sampling activities, including:

- General information, such as field personnel, start and end time, weather conditions, and other miscellaneous observations
- Decontamination procedures for field sampling equipment, collection method, sample depth, number of casts, water depth to sediment surface, time and date of sample collection, sample identification name, and sampler name
- Station coordinates for each sampler cast
- General observations of sample makeup, including odor, color, and texture, and obvious signs of contamination
- Type and quantity of material (woody debris, rocks, shells, etc) removed from a sample grab before homogenization

Each set of samples will be documented and transported to the analytical laboratory using the Laboratory Analytical Request and Chain of Custody forms.

3.5 DISPOSAL OF CONTAMINATED SEDIMENTS

SCUM II notes that it is standard practice in most sediment studies to return excess sediments to the water near the sampling station if they show no obvious signs of contamination. However, if there is reason to believe that there is sufficient contamination to render this practice unsafe, excess sediment should be retained on board and safely disposed of on shore.

SECTION 4: SAMPLE HANDLING PROCEDURES

4.1 SAMPLE CONTAINERS AND LABELS

The testing laboratory will provide the appropriate sample containers. The containers will have been cleaned and prepared by the laboratory according to the methods described in the PSEP protocols. The laboratory will provide any necessary preservatives according to the testing requirements.

Each sample container will have a self-adhesive label, also provided by the testing laboratory. The following information will be recorded on the label at the time of sample collection: project name, sample station number, sampler name, date and time, laboratory test procedure, and preservative, if required.

4.2 CHAIN OF CUSTODY PROCEDURES

A Laboratory Analytical Request and Chain of Custody form will be completed at the time of sampling. One copy of the form will be placed in a waterproof bag and attached to the inside of the cooler. This form will identify each sample by its individual identification number and the date and time collected, and will also identify the analyses requested for each sample. One copy will also be retained by the project manager. The cooler will be sealed and kept in a secure location until delivery to the laboratory.

4.3 SAMPLE STORAGE REQUIREMENTS

4.3.1 Chemical Testing

Samples to be delivered to the laboratory will be kept on ice at 4°C until they are shipped, and will be delivered within 24 hours of shipping. Samples not scheduled for the initial analysis will be archived and stored at the laboratory in a secure area. Storage requirements for the archived chemistry samples will include freezing and storage of the samples at -18°C, with the exception of samples to be analyzed for grain size, ammonia, total sulfides, and volatile organic compounds. Sample preservation techniques and maximum holding time for each laboratory analysis is shown in SCUM II Table 4-7 (Appendix D).

4.3.2 Biological Testing

Samples will be transported to the toxicology lab on ice at 4°C. SCUM II states that once at the laboratory, samples should be stored in the dark at 4°C and should not be frozen, and all analyses should be conducted within two weeks of sampling. The laboratory will report holding times and conditions along with the results of the testing.

SECTION 5: LABORATORY ANALYTICAL METHODS

5.1 CHEMICAL ANALYSIS

All analytical methods will follow the standard testing protocols outlined in SCUM II. An Ecology-accredited laboratory will analyze all sediment samples for the 47 SQS chemicals and conventional sediment variables. The table in Appendix C lists all the analytes to be monitored as well as the associated SQS criteria, recommended sample preparation, cleanup, and analytical methods. The most recent update of the EPA analytical methods shall be used. SCUM II Table D-1, listing target Practical Quantitation Limits (PQLs) and Method Detection Limits (MDLs), is also included in Appendix C.

5.2 QUALITY CONTROL

The sampler will coordinate with the testing laboratory to take all practical measures to achieve lab MDLs that meet the PQLs and the SQS chemical criteria listed in Appendix C (WAC-173-204-320[2][a]). The laboratory will provide written documentation of the procedures and results undertaken to achieve the recommended detection limits.

Total organic carbon (TOC) levels will be analyzed before completing organic chemical analyses. This method is done to avoid MDL exceedances of the SQS when the data is organic carbon normalized.

5.3 BIOLOGICAL TESTING

SCUM II requires that a reference sediment sample be collected from one of three approved reference stations (in Samish Bay, Holmes Harbor, or Carr Inlet) for bioassay comparisons (PTI, 1991). Reference sediments for the bioassay testing are utilized to compare the response of the test to sediments that are known to be unimpacted by chemical contamination. Bioassays will be run with reference sediment that is matched to the test sediment grain size using tables of reference sites furnished by Ecology. SCUM II requires that three bioassay tests be completed for each site exceeding the chemical SQS. Two of the tests are acute effects tests, using both an amphipod and a larval species. The third test is a chronic effects test using either juvenile polychaete or Microtox® 100 percent porewater extract.

5.3.1 Acute Effects Test, Amphipod

The amphipod test is a 10-day acute sediment toxicity test. Choices of amphipod species are *Rhepoxynius abronius*, *Ampelisca abdita*, or *Eohaustorius estuaries*. SCUM II provides guidance on selecting the appropriate amphipod species for the acute effects test based upon interstitial salinity and the percentage of sediment fines, as indicated by the decision tree in Figure 12. The test compares the mortality rates of the selected amphipod species exposed to the test and control sediments at the end of ten days. The test additionally notes the daily emergence and number of amphipods failing to rebury at the end of testing.

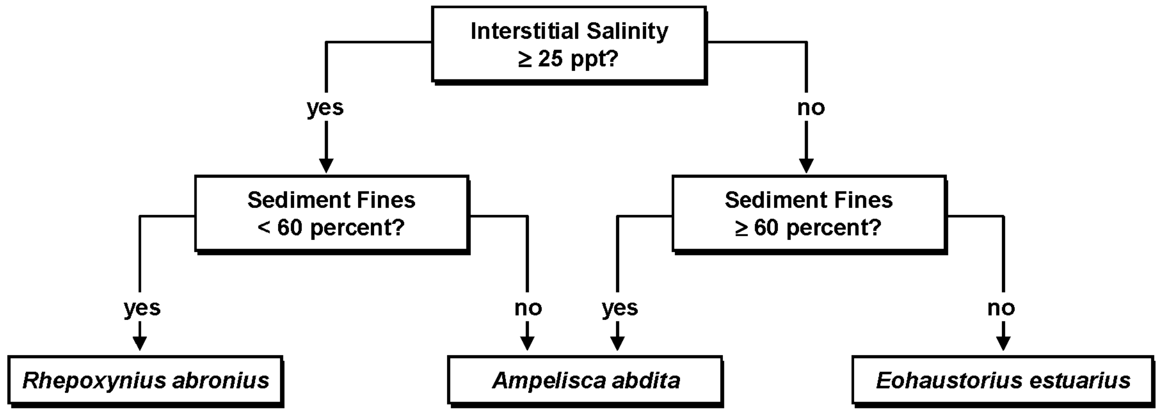

Figure 12 Decision Tree for Selecting Appropriate Amphipod Species for Marine/Estuarine Toxicity Tests

5.3.2 Acute Effects Test, Larval

For the larval acute effects test, adults must be collected in spawning conditions or induced to spawn in the laboratory. As a result, the season in which the analysis takes place often dictates the choice of species for this test. Potential species are:

- *Crassostrea gigas (Pacific oyster)* – Summer
- *Mytilus galloprovincialis (Blue mussel)* – Late Spring through early Summer
- *Strongylocentrotus purpuratus (Purple sea urchin)* – December through April
Strongylocentrotus droebachiensis (Green sea urchin)

- *Dendraster excentricus (Sand dollar)* – April through October

The larval bioassay is a test of the selected organism's mortality and abnormality rates after exposure to the test sediments. The test is run until the appropriate stage of development is achieved in the seawater control. Ten milliliters aliquots are then taken from each of the five replicates for each sample and preserved in 5 percent buffered solution. The larvae are counted to determine the number of larvae and the number failing to develop a complete shell. This data is used to calculate the percent abnormality, percent mortality, and percent combined abnormality and mortality.

5.3.3 Chronic Effects Test

This SSAP recommends the selection of the Microtox® 100 percent porewater extract test for the chronic effects test. An alternative to this test is a 20-day sublethal toxicity test using the juvenile polychaete *Neanthes sp.* This plan does not recommend the benthic macroinvertebrate community analysis due to the increased expense and time required to collect and prepare the samples.

The Microtox® test is "a rapid method of assessing toxicity in marine and freshwater sediment by using the bioluminescent properties of the marine bacteria Vibrio fischeri. The bacteria are exposed to field sediment and the light emitted by the bacteria is used to assess the overall biological condition of the bacteria by comparing to a control. The difference in luminescence is an indication of relative toxicity." (Ecology, 2015) To analyze the sediment quality, 500ml of sediment is first extracted in order to collect approximately 50 ml of pore water from both the reference and test sediment. This pore water is then adjusted for the proper pH, salinity, and dissolved oxygen concentrations. The freeze-dried bacterial suspension is reconstituted and allowed to equilibrate before adding to the test, reference, and control sample. After 15 minutes, the samples luminesce and are measured. The test assumes that the light emitted by the bacteria can be used to make a correlation of the overall biological health of the bacteria exposed to chemical compounds and mixtures. Statistical comparisons are made between the reference and test sediment data. The final analysis includes the testing environment, testing conditions, and positive and negative controls.

If the juvenile polychaete test is selected, the polychaete species *Neanthes sp.* is used in a 20-day test comparing the growth rates of organisms exposed to the test and reference sediments.

5.3.4 Quality Control

Each bioassay analysis must be conducted using both positive (toxic) and negative controls. A reference toxicant such as cadmium chloride, silver chloride, phenol, or sodium lauryl sulfate is used to establish the relative sensitivity/mortalities of the test organisms.

Negative controls are used to measure laboratory performance for the bioassay analyses. Clean reference sediments are expected to produce low mortalities and are used as a negative control for the amphipod and polychaete tests. The negative control for Microtox is distilled or deionized water. If the larval bioassay test is used, seawater will be used as a negative control rather than sediment.

For the marine toxicity tests, there are control limits on the water quality in order to ensure the survival of the organisms and to avoid any stress on the organisms that is not test-related. Daily measurements of the water temperature, salinity, dissolved oxygen, and pH must be taken for the acute effects tests and sulfide and ammonia measurements must be taken at the beginning and end of the test. These same measurements are made every three days if *Neanthes* bioassays are completed. For Microtox, SCUM II requires a pH between $7.9 < pH < 8.2$, and monitoring of the temperature, salinity, and dissolved oxygen.

SECTION 6: QUALITY ASSURANCE/QUALITY CONTROL

6.1 LABORATORY QA/QC

The chemical samples will be analyzed at an analytical laboratory that is accredited by the State of Washington Department of Ecology. The analytical laboratory will follow quality control requirements for the selected analytical methods using the quality control procedures outlined in SCUM II and PSEP protocols for each type of test. The laboratory analyst is responsible for identifying analytical problems and taking corrective actions, and should communicate any problems with the project manager. Quality control procedures for organic analyses are listed in SCUM II Table 5-3, and for metals and conventionals analyses in Tables 5-4 and 5-5, respectively. All procedures are outlined in greater detail in their corresponding chapters in the PSEP protocols, which can be found online at:

https://fortress.wa.gov/ecy/publications/documents/1509046.pdf

Tables 5-3–5-5 are included in Appendix E.

6.2 DATA QUALITY ASSURANCE REVIEW

After testing has been completed, the project quality assurance manager will review the field documentation and laboratory data packet, including:

- Compliance with the planning document
- Proper sample collection and handling procedures
- Holding times within those outlined in protocols
- Completeness and acceptability of data
- Review of data qualifiers/flags based on laboratory quality control tests

The quality assurance review will follow guidance provided in PTI (1989a), and will be documented in the final report.

SECTION 7: DATA ANALYSIS, RECORD KEEPING, AND REPORTING

7.1 DATA ANALYSIS

7.1.1 Sediment Chemistry and Bioassay

Sediment chemistry will be tabulated in a spreadsheet with the conventional values at the top of the table for easy reference. Separate tables will be prepared for dry-weight and TOC-normalized concentrations. If the TOC is below 0.5 percent and the analyte has a non-detect concentration with the MDL below the dry weight criteria, the analyte will be in compliance with the numeric standard. The tabulated data will also include the sample station identification number, date of sample collection, sediment sampling depth interval, and the SMS criteria.

All test, reference, negative control and positive control data for the bioassay testing will be included in the final report. Positive control data will also be submitted showing the last 12 months of positive control data or the last 15 control tests, whichever is greater.

Results of the chemical and bioassay testing will be analyzed using the MyEIM tool, which can be found online at:

http://www.ecy.wa.gov/eim/myEIM.htm

Chemical/bioassay analysis results obtained using the MyEIM tool will be cross-checked, and any unexpected differences will be noted and explained in the Data Report.

7.1.2 Data Interpretation

The final report will compare test results to the relevant chemical or biological effects identified in the SMS. Results will also be compared to the sediment quality established by previous monitoring at the sample sites to determine the impact the discharge has had on the surrounding sediments.

7.2 RECORD KEEPING AND REPORTING

All sediment sampling and testing records will be maintained in a project file for no less than 10 years in accordance with the requirements of Section 610 of the SMS. The records will be provided upon request, or made available at reasonable times for inspection, to authorized personnel.

The results of the sediment sampling and analysis will be presented in a report for submittal to Ecology that follows the guidance in Section A.7 of the SCUM II. The report will include graphics for sampling stations, sample collection methods and coordinates, sample receiving, compositing, shipping and archiving, and quality assurance and quality control for the sample collection and analysis. Results will be compared to the SQS criteria.

Hard copy data reports will be given to Ecology. The sediment data will also be provided electronically in Ecology's EIM template format for inclusion in the EIM database. That data will be entered into the required EIM data entry templates to ensure for proper and error-free formatting prior to submittal to Ecology. Any data exceeding the SQS criteria levels will be highlighted in the data tables using bold text.

SECTION 8: REFERENCES

PTI Environmental Services. 1989a. *Data quality evaluation for proposed dredged material disposal projects*. Prepared for Washington Department of Ecology, Sediment Management Unit.

PTI Environmental Services. 1991. *Reference Area Performance Standards for Puget Sound.* EPA Contract 68-D8-0085.

Puget Sound Estuary Program. 1997. *Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound.*

U.S. Environmental Protection Agency (EPA), 2000. *EPA Superfund Record of Decision – Puget Sound Naval Shipyard Complex, Bremerton, Washington.*

United States Geological Survey (USGS), 2009. *Mercury in Sediment, Water and Biota of Sinclair Inlet, Puget Sound, Washington, 1989-2007*. Open-File Report 2009-1285. http://pubs.usgs.gov/of/2009/1285/.

Washington Administrative Code 173-204. *Sediment Management Standards.*

Washington State Department of Ecology. 2015. *Sediment Cleanup Users Manual II*. Ecology Publication No. 12-09-057.